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The Use of the Rasch Model to Analyze Misconceptions on the Topic of Integer Numbers

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A B S T R A K

Para siswa masih mengalami kesulitan dan banyak miskonsepsi siswa terhadap konsep matematika, khususnya operasi bilangan bulat. Urgensi penelitian didasarkan pada fakta miskonsepsi tersebut dapat mempengaruhi perkembangan pemahaman siswa dalam matematika. Tujuan untuk mengidentifikasi dan menganalisis kesalahan dan miskonsepsi siswa dalam operasi pengurangan bilangan bulat menggunakan Model Rasch*. Metode penelitian yang digunakan adalah kuantitatif dengan pendekatan survei, yang dilaksanakan pada 675 siswa sekolah dasar dan sekolah menengah di Makassar, Indonesia. Data dikumpulkan melalui instrumen soal pilihan ganda yang disusun sesuai standar kurikulum matematika, kemudian di analisis menggunakan* Model Rasch *untuk mengidentifikasi tipe miskonsepsi dan tingkat kesulitan soal. Hasil penelitian menunjukkan bahwa miskonsepsi utama berkaitan dengan pemahaman simbol negatif dan konsep keseimbangan numerik. Temuan ini mengindikasikan perlunya pengembangan instrumen diagnostik yang lebih komprehensif dan peningkatan pelatihan guru dalam pembelajaran bilangan bulat. Kesimpulan, penggunaan* Model Rasch *terbukti efektif dalam mengidentifikasi miskonsepsi dan dapat menjadi dasar pengembangan strategi pembelajaran. Implikasi penelitian mendukung pelatihan guru dan metode pembelajaran konsep matematika.*

A B S T R A C T

Students still experience difficulties and many misconceptions about mathematical concepts, especially integer operations. The urgency of the research is based on the fact that these misconceptions can affect the development of students' understanding in mathematics. The aim is to identify and analyse students' errors and misconceptions using the Rasch Model. The research method used is quantitative with a survey approach, with respondents of 675 elementary and high school students in Makassar. Data were collected through instruments, multiple-choice questions arranged according to mathematics curriculum standards, then analysed using the Rasch Model to identify the type of misconception and the level of difficulty of the questions. The results show that the main misconceptions are related to the understanding of negative symbols and the concept of numerical balance. These findings indicate the need to develop more comprehensive diagnostic instruments and improve teacher training in integer learning. In conclusion, the use of the Rasch Model has proven effective in identifying misconceptions and can be the basis for developing learning strategies. The implications of the research support teacher training and methods for learning mathematical concepts.

1. INTRODUCTION

Mathematics is a subject that develops logical and systematic thinking for solving problems, making decisions, and analyzing axiomatic principles that explain abstract structures using logic and mathematical symbols (Biagioli, 2020; Suwarto et al., 2023). In mathematics, one of the fundamental concepts is that of integers. Integers involve both knowledge and skills related to numbers. This study focuses on the topic of integers by identifying misconceptions that often occur among students,

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particularly in relation to subtraction operations. A misconception is a condition in which a person understands a concept differently from how it is academically recognized. In this study, misconception refers specifically to students' misunderstandings regarding integer operations, especially those involving negative integers (Bryant et al., 2020; Wen & Dubé, 2022).

Based on reports issued by the Indonesian Examination Board (1999, 2002, 2005, 2008, 2011, 2014, 2017, 2021, and 2023), many participants of the Low Middle Assessment, as well as Indonesian students in general, experience misconceptions regarding the basic concepts of addition, subtraction, division, and multiplication of positive and negative integers. Evidence of these misconceptions can be seen in students' errors when solving problems involving negative integers, such as providing answers like –8w – (3w) = 11w*,* –17 + (–3) = 20*,* –15 – 4 = –11*, and* –17 + 4 = 13. According to the curriculum syllabus, the topic of integers has been introduced to students at the first level: Topic 6, *Integers* (Integrated High School Curriculum, KTSP, and KBK) or the first topic, *Rational Numbers* (National Standard High School Curriculum). This indicates that many students still struggle to master the basic concepts of integers and continue to experience misconceptions from the first-grade level (Nastiti & Syaifudin, 2020; U. Hasanah et al., 2023). This situation will have a major impact when students continue to the second, third, fourth, and fifth levels and will subsequently affect their mathematics learning outcomes. In addition, this misconception will also affect their understanding of other topics such as fractions, transformations, and algebra. This misconception problem is worrying because negative number arithmetic operations are the most basic concepts in mathematics (Guerra-Reyes et al., 2024; Moons et al., 2022). Therefore, mastery of the basic concept of integers needs to be emphasized from the beginning so that misconceptions do not occur at the next level of learning. This situation will have a major impact when students continue to the second, third, fourth, and fifth levels and will subsequently affect their mathematics learning outcomes. In addition, these misconceptions also affect their understanding of other topics such as fractions, transformations, and algebra (Fitriasari et al., 2025; Harun et al., 2023).

This misconception problem is worrying because negative number arithmetic operations are the most basic concepts in mathematics. Therefore, mastery of basic integer concepts must be emphasized from the beginning to ensure that misconceptions do not occur at the next level of learning. This situation will have a big impact when students move on to the second, third, fourth, and fifth levels and further affect their mathematics results. In addition, this misconception also affects their understanding of other topics such as fractions, transformations, and algebra. This misconception problem is worrying because negative number arithmetic operations are the most basic concepts in mathematics. Therefore, mastery of basic integer concepts must be emphasized from the beginning to ensure that misconceptions do not occur at the next level of learning. Transformation and algebra. This misconception problem is worrying because negative number arithmetic operations are the most basic concepts in mathematics (Mejía-Rodríguez et al., 2021; Moons et al., 2022). Therefore, mastery of basic integer concepts must be emphasized from the beginning to ensure that misunderstandings do not occur at the next level of learning. Transformation and algebra. This misunderstanding problem is worrying because negative number arithmetic operations are the most basic concepts in mathematics. Therefore, mastery of basic integer concepts must be emphasized from the beginning to ensure that misunderstandings do not occur at the next level of learning (Bryant et al., 2020; Harun et al., 2023).

Previous research conducted in Indonesia and abroad only focused on students' understanding of integers, especially negative integers study how students think about negative number misconceptions (Shahparvari et al., 2020; Wen & Dubé, 2022) and types of student misconceptions about integers (Bryant et al., 2020; Hughes et al., 2020). In previous studies with qualitative approaches used in research such as interviews and analysis of student misconceptions with short questions have several limitations from the methodological aspect. The classical method used in previous studies, namely the Kuder-Richardson formula (KR20), has two weaknesses, namely respondent-dependent problems and item-dependent problems (Guerra-Reyes et al., 2024; Mandinach & Schildkamp, 2021).

Thus, the Rasch model, which is one of the models in Item Response Theory (IRT), is said to be more appropriate for analyzing students' misconceptions on integers through multiple-choice questions, because this model has two characteristics, namely first, the Rasch model involves the fewest parameters, therefore it is easier to apply; second, the Rasch model has a special purpose, namely allowing complete separation of test items and estimation ability (Aryadoust et al., 2021; Gordon et al., 2021). Penggunaan Option Probability Curves (OPC) pada model Rasch untuk mengidentifikasi jenis miskonsepsi yang dilakukan oleh siswa dalam penelitian ini didasarkan pada tingkat kemampuan siswa. Metode ini lebih sederhana dan sistematis dibandingkan dengan metode yang digunakan oleh penelitian-penelitian sebelumnya. Artinya kurva OPC memiliki kelebihan dari aspek identifikasi miskonsepsi siswa, jenis miskonsepsi yang dihadapi oleh siswa dari tingkat kemampuan tinggi dan tingkat kemampuan rendah.

Analisis kurva OPC pada model Rasch memiliki tingkat reliabilitas yang lebih tinggi dibandingkan dengan analisis miskonsepsi penelitian-penelitian sebelumnya dengan metode persentase, because students' misunderstandings in the OPC curve are analyzed based on students' ability levels, not averages or percentages (Guggemos, 2021; Pals et al., 2023).

Piaget's cognitive theory and the pseudo-concept model presented, have been applied in this study to identify the type of misconceptions of first-grade students in the topic of integer number subtraction operations, especially negative integers (Hamzah et al., 2021; Huang, 2021). Cognitive development is a genetic process, a process that involves biological methods in the development of the nervous system. The older a person is, the more complex the arrangement of their nerve cells and the more their abilities increase (Castellani & Schwartz, 2020; Pattabiraman et al., 2020). According to him, in the learning process when a person faces a new stimulus (new thing), there are two processes used by individuals to try to adapt, namely assimilation and accommodation. Assimilation is a process of changing or using new stimuli encountered to be placed in an existing cognitive structure (Conway, 2020; Mubarik et al., 2020).

A person is said to experience an adaptation process through assimilation if the individual combines new information received into the knowledge he already has. In this study, the assimilation process is said to be carried out by students by solving subtraction problems between two integers involving arithmetic processes. Accommodation is the process of changing a person's cognitive structure to adapt to new stimuli (Dantas & Cunha, 2020; Inayati, 2020). Therefore, accommodation occurs when individuals adapt to new information, and existing cognitive structures undergo changes to adjust to the stimulus received. In this study, the accommodation process is said to occur when students solve problems involving negative integers that use negative symbols in subtraction operations. When students try to solve problems involving subtraction operations of two negative integers, the students are said to be carrying out an equilibrium process (balance of the assimilation and accommodation processes), because at the same time, students are involved in an arithmetic process that uses negative symbols (Bryant et al., 2020; Fitriasari et al., 2025).

In this study, when a student solves a math problem about subtracting negative integers, the student's cognitive process will carry out cognitive balance involving cognitive balance of assimilation and accommodation. Cognitive assimilation involves the subtraction operation between two numbers (arithmetic) and cognitive accommodation involves understanding the concept of negative integers (use of symbols). Students can achieve cognitive balance if both cognitive processes of assimilation and accommodation are carried out successfully. However, failure in the cognitive process will cause a pseudo-concept model, namely the failure to master the true meaning conveyed in a concept. The failure of students in cognitive assimilation will cause a pseudo-concept of assimilation that fails in the subtraction operation between two numbers (arithmetic misconception). The failure of students in cognitive accommodation will cause a pseudo-concept of accommodation that fails to understand the concept of negative integers (negative symbol misconception). The failure of students in cognitive balance will cause a pseudo-concept of balance that fails in solving math problems of subtracting negative integers (arithmetic and negative symbol misunderstandings) (Bryant et al., 2020; Fitriasari et al., 2025).

The novelty of this research lies in its focus on identifying in depth various forms of student misconceptions in integer operations, especially subtraction, by utilizing the analysis of the Rasch model. Most previous studies have placed more emphasis on the effectiveness of certain learning strategies without exploring in detail the types of conceptual errors students experience. This research presents a new approach using valid and reliable instruments so that it not only measures the difficulty level of the questions, but is also able to simultaneously map the patterns of misconceptions that arise. These findings will be the basis for designing more targeted learning programs, providing data-based training to teachers, and encouraging the curriculum to be more adaptive to the real needs of students. Thus, this research contributes to novelty in the form of the integration of modern psychometric analysis in an effort to overcome the gap between the theory and practice of mathematics learning in Indonesia. The main objective of this study was to identify the types of misconceptions experienced by students regarding integers using the Rasch model. This study also aims to develop an effective and reliable diagnostic tool to detect these misconceptions and analyse the level of difficulty and distribution of misconceptions objectively. The results of this study are expected to guide teachers in designing more effective learning strategies, improving students' understanding of the concept of integers, and supporting the development of a mathematics curriculum that focuses more on conceptual understanding.

2. METHOD

The research method used is quantitative with a survey type. The survey research method was used to determine the achievement of research objectives (Creswell, J. W. & Creswell, 2018; Kotronoulas et al., 2023). The random sampling method using cluster sampling, better known as cluster random sampling, was used in this study. A total of 675 students from 8 senior high schools spread across Makassar, Indonesia. Among them, 335 are male students and 340 are female students. The instrument is built based on the Mathematics Curriculum and Assessment Standard Document (MCASD) Class 1 in the syllabus. In the Item Specification, it is built as a reference for instrument construction. This instrument contains 42 objective questions, also known as multiple-choice questions, based on 4 operational categories and 2 types of objections that have 4 answer choices. In addition, it once again functions as a distraction to identify the type of student misconceptions. The construction of this instrument is based on the construction model Approach 4: identifying student errors aims to identify the types of misunderstandings, mistakes, errors, or misconceptions that students often make (Hughes et al., 2020; Moons et al., 2022). Indicators and research instruments in Using the Rasch Model to Analyze Misconceptions can be seen in Table 1.

Table 1. Indicators and Research Instruments in Using the Rasch Model to Analyze Misconceptions

Indicator	No	Item
Integer Concepts and Operations	1	I understand that integers consist of positive, negative, and zero.
	2	The result operands I know that subtracting integers involves determining the difference and the sign of
	3	I understand that subtracting negative integers can be thought of as addition.
	4	I understand that subtracting integers does not always involve subtracting directly.
	5	I can correctly determine the result of subtracting integers.
	6	I understand that the sign of the result of subtraction depends on the value and sign of the
	7	I know that subtracting negative numbers can produce a positive result.
	8	I am able to explain the process of subtracting integers verbally.
	9	I understand that subtracting integers can be understood through graphical representation.
	10	I understand that integers are used in a variety of real-life contexts.
Misconception Identification Results of Reduction	1	I believe that subtracting negative integers always results in a negative result.
	2	I believe that the result of subtracting integers is always smaller than the original number.
	3	I believe that subtracting positive and negative integers always results in a positive number.
	4	I believe that the sign of the result of subtraction is independent of the sign of the operands.
	5	I believe that subtracting larger numbers always results in a smaller number.
	6	I believe that subtracting integers is always done by subtracting their absolute values.
	7	I believe that the result of subtraction always retains the sign of the first number.
	8	I feel that subtracting negative integers is always the same as adding value.
	9	I believe that the sign of the result of subtraction is only affected by the last number subtracted.
	10	I believe that the result of subtraction of integers cannot be negative.
Using Visual Representation in Calculating Subtraction of Integers	1	I can create a number line to facilitate understanding of subtraction.
	2	I am able to draw a diagrammatic representation to complete the operation of subtracting integers.
	3	I use a bar or block model to explain subtraction of integers.
	4	I am able to show the process of subtracting integers using a graph.
	5	I can explain the results of subtracting integers through pictures.
	6	I use visual representations to help understand the signs of the subtraction results.
	7	I am able to visualize the subtraction of integers in the form of illustrations.
	8	I can compare the results of subtraction with graphical representations before

Indicator	No	Item
		determining the answer.
	9	I am accustomed to using diagrams to solve integer subtraction problems.
	10	I am able to interpret visual representations in solving subtraction problems.
The Effect of Using Strategy in Solving Subtraction of Integers	1	I use the addition strategy when subtracting negative integers.
	2	I follow specific steps to complete integer subtraction operations.
	3	I feel confident when using a visual approach to integer subtraction.
	4	I try different strategies to check the results of integer subtraction.
	5	I understand that effective strategies can speed up the subtraction process.
	6	I follow the correct procedure when working on integer subtraction problems.
	7	I find it difficult to use strategies other than direct subtraction.
	8	I actively think when choosing a strategy to solve subtraction problems.
	9	I believe that practicing with different strategies can improve my understanding of integer subtraction.
	10	I am able to choose the right strategy according to the context of the subtraction problem.

The data analysis technique using the Rasch model assumption analysis in determining the validity and reliability of the instrument shows a standardized variance (PCA) value of 71.4% and the unclear raw variance threshold values for factors 1, 2, 3, 4 and 5 were 3.7, 2.8, 2.6, 2.2 and 1.7 respectively (<5: Linacre, 2003), the CORR PTMEA value was between 0.12 and 0.68 (≥0.3), can contribute to the measurement of respondents' misconceptions because it is still a positive value, as many as 38 items (95%) meet the requirements of MNSQ infit (0.6–1.4: and as many as 35 items (87.5%) meet the requirements of MNSQ outfit (0.6–1.4: Linacre, 2003), t-test values in Differential Item Functioning (DIF) for 40 items in the range between −2.0 to +2.0, and the value of Content Validity Index (CVI) in the content validity is 0.80 (>0.78) (Linacre et al., 2003; Menegol et al., 2022; Sebsibe et al., 2023). During the data collection process, students were asked to sit in a position similar to the test position and were given 30 minutes to answer. The data of this study were manually checked before using Win steps software version 3.57.2 to identify the types of misconceptions made by students in the operation of subtracting negative integers. The distractor analysis for each item was carried out using the Rasch model. The item.

3. RESULT AND DISCUSSION

Result

Confounder analysis was conducted to identify the types of misconceptions made by first grade students based on the pseudo-conception model by examining the OPC curve. Interrupter analysis was conducted based on 4 categories of subtraction operations, namely: (i) subtraction of positive integers with positive integers, (ii) subtraction of negative integers with positive integers, (iii) subtraction of positive integers with negative integers, and (iv) subtraction of negative integers with negative integers. Based on the OPC curve, in addition to the correct answer option (the OPC curve is shaped like an ICC curve Item Characteristic Curve), the other three distractor options are said to have low probability at each student's ability level (the OPC curve is horizontal) (Guerra-Reyes et al., 2024a; Kristoffersson & Lindén, 2022). If the OPC curve for each distractor is not horizontal at a low probability level, the student is said to be facing a misconception about that item, and the type of misconception faced is based on the student's choice of distractor. In other words, if the probability of the distractor OPC curve has a high value, it means that the student is facing a misconception about the choice of the distractor (Bautista et al., 2023; Gennari et al., 2023; Retnawati et al., 2023). Subtraction Operation of Positive Integers with Negative Integers. This subtraction operation category is divided into groups of large absolute numbers subtracting small absolute numbers (a – b) =, |a|>|b|), and small absolute numbers subtracting large absolute numbers (a – b =, |a|<|b|). 2 to 6 are the OPC items for the group (a – b =, |a|>|b|).

These five items (items 6, 14, 22, 32, and 38) have answer option A to detect students' arithmetic misconceptions facing the pseudo-conception of assimilation, answer option C to detect students' symbolic misconceptions facing the pseudo-conception of accommodation, and answer option D detecting students' arithmetic and symbolic misconceptions facing the pseudo-conception of balance, while answer B is the correct answer; representing students who can master this subtopic. Based on s 2 to 6 (items 6, 14, 22, 32, and 38) it can be concluded that in the operation of subtracting positive integers with the category of positive integers (|a| >|b|) students who face misconceptions are mostly arithmetic misconceptions (answer choice A) caused by the pseudo-concept of assimilation. In s 6 it can be seen that all levels of student ability can master this subtopic because each level of student ability (−2.0 logit to 1.0

logit) has a high probability (around 0.8 logit) to answer correctly on the item (answer choice B), except for the level of student ability at −2.0 logit to −1.5 logit recorded a lower probability (0.6 logit). It is difficult to distinguish students' actual abilities in mastering the topic of subtracting negative integers based on items in this category. From the aspect of misconception, there are several students with low ability levels (-2.0 logit to -1.5 logit) who face arithmetic misconceptions due to the pseudo-concept of assimilation (answer choice A), especially in questions 6, 32, and 38. Questions 14 and 22 show that several students with low ability levels (-2.0 logit to -1.5 logit) face pseudo-concepts of accommodation which lead to symbol misconceptions (answer choice C). Question 14 is a special question because at high levels of student ability (0.5 logit to 1.0 logit), students experience arithmetic misconceptions.

Questions 4, 25, 26, 34, and 36 are questions on subtraction operations of positive integers with positive integers in the category of small absolute numbers that subtract large absolute numbers (a – b =, |a|＜|b|). The OPC curve for questions in this category has been created. Answer choice A for these five questions is designed to detect students' arithmetic and symbolic misconceptions facing the pseudo-concept of equilibrium, answer choice B to detect students' symbolic misconceptions facing the pseudo-concept of accommodation, answer choice D to detect students' arithmetic misconceptions facing the pseudo-concept of assimilation, and answer choice C is the correct answer that shows that students can master this subtopic. Based on questions 4, 25, 26, 34, and 36, it was found that in the operation of subtracting positive integers in the category of positive integers (|a|＜|b|) students who faced misconceptions were mostly symbol misconceptions (answer choice B) caused by the pseudo-conception of accommodation. Based on the OPC curve shown by questions 4 and 36, both questions showed that all levels of student ability could master the questions because all levels of student ability ranging from -1.5 logit to 2.0 logit chose the correct answer choice (choice C). While questions 25, 26, and 34 showed the level. Students' abilities at -1.5 logit to -1.0 logit and -0.5 logit to 2.0 logit mostly choose the correct answer (option C), but at the ability level of -1.0 logit to -0.5 logit students choose answer option B. These three items 25, 26, and 34 have proven that students at the ability level of -1.0 logit to -0.5 logit experience the pseudo-concept of accommodation which leads to symbol misunderstanding. Items 4, 25, 26, and 34 also show that at the student ability level of around 1.5 logit, more students choose D as their answer because they face arithmetic misunderstandings about the effects of the pseudo-concept of assimilation. Referring to 7, item 4 shows that at the student ability level of -0.5 logit to 1.0 logit there are some students who face symbol misconceptions, Summary from Table 1, in the operation of subtracting positive integers with categorical positive integers (|a|＞|b|), students who face misconceptions are mostly arithmetic misconceptions rather than symbolic misconceptions. On the other hand, more students face symbolic misconceptions than arithmetic misconceptions in the category (|a|＜|b|). However, in the group of students who experience misconceptions, most of the misconceptions faced by first grade students in the operation of subtracting positive integers with positive integers are arithmetic misconceptions, the result of assimilation pseudo-conceptions. The pseudo-concept of balance that causes arithmetic and symbolic misconceptions is less encountered by first grade students in the operation of subtracting positive integers with positive integers. As a summary, the types of misconceptions faced by first grade students can be examined in Table 2. Thus, it can be concluded that most students face symbolic misconceptions (accommodation pseudo-conceptions), followed by arithmetic misconceptions (assimilation pseudo-conceptions), and finally arithmetic and symbol misconceptions (balance pseudo-conceptions). Accommodation pseudo-conceptions (symbol misunderstandings) are the problems faced by most first grade students when solving problems on subtraction of negative integers. Misconception of the operation item of subtracting positive integers with negative integers can be seen at Table 2**.** Misconceptions analysis of items in the instrument IDTNISO can be seen at Table 3**.**

Tabel 2. Misconception of the operation item of subtracting positive integers with negative integers

		Kind of a misconception		Arithmetic &
a – b	**Item Number**	**Arithmetic (Pseudo Assimilation Conception)**	**Symbols (Pseudo-Accommodation Conception)**	**Symbols (Pseudo-Conception Equilibrium)**
|a| > |b|	6	❖		
	14	❖	❖	
	22		❖	
	32	❖		
	38	❖		
|a| < |b|	4	❖	❖	
	25	❖	❖	

		Kind of a misconception		**Arithmetic &**
a – b	**Item Number**	**Arithmetic (Pseudo Assimilation Conception)**	**Symbols (Pseudo-Accommodation Conception)**	**Symbols (Pseudo-Conception Equilibrium)**
	26	❖	❖	
	34	❖	❖	
	36		❖	

Table 3. Misconceptions analysis of items in the instrument IDTNISO

			Types of misconceptions		
Denial operation	**a – b**	**Item number**	**Arithmetic (pseudo-assimilation conception)**	**Symbol (pseudo-Accommodation conception)**	**Arithmetic & symbols (pseudo conception of equilibrium)**
		6	❖		
		14	❖	❖	
	|a| > |b|	22	❖	❖	
Positive integer with integers positive		32	❖		
		38	❖		
		4	❖	❖	
		25	❖	❖	
	|a| < |b|	26	❖	❖	
		34	❖	❖	
		36	❖	❖	
		1	❖	❖	
		13	❖	❖	
	|a| > |b|	16	❖	❖	
		24	❖	❖	
Negative integer with integers positive		37	❖	❖	
		3	❖	❖	
		9	❖	❖	❖
	|a| < |b|	28	❖	❖	❖
		30	❖	❖	❖
		40	❖	❖	❖
		2	❖	❖	
		17	❖	❖	❖
	|a| > |b|	21	❖	❖	❖
		23	❖	❖	❖
		39	❖	❖	❖
		8		❖	❖
	|a| < |b|	10		❖	❖
		15		❖	❖
		19		❖	❖
	|a| > |b|	33	❖	❖	❖
		5	❖	❖	❖
		7	❖	❖	❖
		12	❖	❖	❖
Negative integer with integers negative		18	❖	❖	❖
		20	❖	❖	❖
		11	❖	❖	❖
		27	❖	❖	❖
	|a| < |b|	29	❖	❖	❖
		31	❖	❖	❖
		35	❖	❖	❖

Discussion

It was found in this study that the majority of students faced arithmetic misconceptions caused by the problem of assimilation pseudo concept when trying to solve subtraction problems involving positive integers with positive integers. Overall, the majority of first grade students who experienced misconceptions in this study were those who had problems with accommodation pseudo conceptions that led to symbol misconceptions when solving problems in the instrument (Bryant et al., 2020; Harun et al., 2023). As a result, it can be said that most students failed to carry out the cognitive process of accommodation when trying to solve problems in the instrument. Students' failure in cognitive accommodation involves students adapting to new stimuli with negative integers using negative symbols has occurred in the respondents of this study. This failure also triggers the problem of students' pseudo concept of accommodation, thus causing symbol misconception, namely the failure of cognitive accommodation in mastering negative integers (Cazals et al., 2023; Mandinach & Schildkamp, 2021). In other words, students have misunderstood the actual function of negative symbols in negative integers and carry symbol misconceptions when solving problems on the instrument.

Regarding integer misconceptions, they focus more on identifying the types of misconceptions that occur in students, no conclusions are made by researchers regarding the types of misconceptions (Brown et al., 2020; Mandinach & Schildkamp, 2021b; Muis et al., 2020). Until now, there has been no previous research on integer misconception diagnostic tests with Rasch model analysis. The classical method in data analysis and content validity alone which are prioritized in previous studies have also become an issue that has been widely discussed lately because it has weaknesses in terms of psychometric characteristics, namely content validity and percentage units which cause this study to face dependent-group (respondent-dependent) and dependent-item (item-dependent) problems. Content validity is not enough to be used as evidence in determining the construct validity of the test and test interpretation, construct validity which is prioritized in the Rasch model is said to be more appropriate than content validity alone which is used in determining the validity of the instrument. In this study, the involvement of the pseudo concept model and analysis of student misconceptions based on the Rasch model OPC curve in this study helps teachers more easily understand the misconceptions faced by students (Muis et al., 2020; Vrotsou et al., 2023). The analysis of the Rasch model in student misconceptions with the OPC curve makes it easier for teachers to identify the types of student misconceptions based on the level of student ability, therefore activities or explanations that prioritize construct validity in the Rasch model are said to be more appropriate than content validity alone which is used in determining the validity of the instrument. In this study, the involvement of the pseudo concept model and analysis of student misconceptions based on the Rasch model OPC curve in this study helps teachers more easily understand the misconceptions faced by students. Rasch model analysis on student misconceptions with OPC curves makes it easier for teachers to identify types of student misconceptions based on student ability levels, therefore activities or explanations that prioritize construct validity in the Rasch model are said to be more appropriate than content validity alone which is used in determining instrument validity. In this study, the involvement of pseudo concept models and analysis of student misconceptions based on the Rasch model OPC curve in this study helps teachers more easily understand the misconceptions faced by students. Rasch model analysis on student misconceptions with OPC curves makes it easier for teachers to identify types of student misconceptions based on student ability levels, therefore activities or explanations that prioritize reinforcement exercises can be implemented by teachers more appropriately (Aryadoust et al., 2021; Gordon et al., 2021).

The implications of this study regarding students' misconceptions in the operation of subtracting negative integers are very important to be carried out, especially in the context of mathematics education. This study shows that many students have difficulty in understanding basic concepts related to the dynamics of subtracting negative integers. This finding emphasizes the need to develop effective diagnostic instruments such as IDTNISO to detect misconceptions faced by students. By understanding in depth, the types of misconceptions, teachers can design more targeted and efficient learning strategies. This is also possible through the use of educational technology, where instruments such as IDTNISO can be integrated into computer-based learning systems or mobile applications, so that students can work on diagnostic tests independently and get quick feedback (Bryant et al., 2020; Fitriasari et al., 2025).

This study underlines the importance of training for educators in using the Rasch model as an analysis tool. Mathematics teachers need to be equipped with sufficient understanding of how to interpret data generated from Rasch analysis, so that they can intervene appropriately when they encounter students with specific misconceptions. In this regard, seminars or workshops that focus on professional development for mathematics teachers can be a good step to improve their competence in recognizing and overcoming misconceptions (Aryadoust et al., 2021; Vrotsou et al., 2023). The development of an inclusive curriculum that emphasizes conceptual understanding and critical thinking should also be considered, in order to build a strong foundation for students at the next level of education. The findings of this study encourage the need for collaboration between researchers, educators, and education policy makers in creating a learning environment that better supports mathematical understanding (Afifah & Kusuma, 2021; Vrotsou et al., 2023). With this synergy, it is hoped that more systematic intervention programs can be realized that are based on strong empirical data. For example, remedial programs that are specifically designed based on an analysis of student misconceptions can be implemented to help those who are experiencing difficulties. In addition, it is also important to involve parents in the learning process, considering that they can function as the main supporters for students at home. The implications of this study are not only limited to the academic context, but also affect the development of student character. Overcoming misconceptions must be done with an approach that considers the psychological aspects of students. Understanding that they are experiencing difficulties in a friendly and supportive manner can increase their confidence and motivation in learning mathematics. Learning that is oriented towards problem solving and group discussions can be a good platform to facilitate this. Thus, mathematics education is not only transformed into a means of transferring knowledge but also in building skills and positive attitudes towards mathematics among students (Hamzah et al., 2021; Muis et al., 2020).

This research has several limitations, so further development is needed to understand and overcome students' misconceptions about integers, especially in subtraction operations. It is suggested that further research involve a wider and more diverse population to make the results more representative. Diagnostic instruments also need to be developed with variations of question forms, such as essays or visual representations, to explore students' thinking processes in more depth. In addition to the cognitive aspect, the learning approach should also pay attention to the emotional and social factors that affect students' attitudes towards mathematics. Teacher training is important to strengthen understanding of misconceptions, strategies for handling them, and the use of interactive technology. Longitudinal research is recommended to monitor the development of students' understanding over time, while a combination of quantitative and qualitative approaches can provide a more comprehensive picture of the learning process and students' difficulties.

4. CONCLUSION

The conclusion of this study is that the use of the Rasch model to analyze students' misconceptions about integer operations, especially subtraction, has proven effective in identifying and measuring students' level of understanding more accurately. The developed diagnostic tool can detect various types of misconceptions faced by students, supported by excellent validity and reliability. This approach allows mapping of students' abilities based on the Option Probability Curve so that misconception analysis can be adjusted to the level of ability of each student. It is believed that the application of educational technology and teacher training in the use of Rasch analysis will increase teachers' efficiency in addressing misconceptions in a targeted manner, helping them design more effective and intriguing learning strategies. This study also emphasizes the importance of collaboration between researchers, teachers, and policymakers to create a learning environment that supports the development of mathematical concepts in depth and pays attention to students' psychological and social aspects. However, the limited sample size and the tool that only relies on a few options indicate the need for additional research that includes various tools and is on a larger scale to obtain a more comprehensive picture. Considering these limitations, this study provides a strong foundation for developing more comprehensive and transformative diagnostic methods and learning strategies, with the aim of improving students' understanding and reducing misconceptions in mathematics lessons, especially in integer operations.

5. REFERENCES

Afifah, S. N., & Kusuma, A. B. (2021). Pentingnya Kemampuan Self-Efficacy Matematis Serta Berpikir Kritis Pada Pembelajaran Daring Matematika. *JURNAL MathEdu (Mathematic Education Journal)*, *4*(2), 313–320. https://doi.org/10.37081/mathedu.v4i2.2642.

Aryadoust, V., Ng, L. Y., & Sayama, H. (2021). A comprehensive review of Rasch measurement in language assessment: Recommendations and guidelines for research. *Language Testing*, *38*(1), 6–40. https://doi.org/10.1177/0265532220927487.

Bautista, L., Maradei, F., & Pedraza, G. (2023). Strategies to reduce visual attention changes while learning and training in extended reality environments. *International Journal on Interactive Design and Manufacturing*, *17*(1), 17–43. https://doi.org/10.1007/s12008-022-01092-9.

Biagioli, F. (2020). Ernst Cassirer's Transcendental Account of Mathematical Reasoning. *Studies in History and Philosophy of Science Part A*, *79*(February 2020), 30–40. https://doi.org/10.1016/j.shpsa.2019.10.001.

Brown, S. A., Ronfard, S., & Kelemen, D. (2020). Teaching Natural Selection in Early Elementary Classrooms: Can A Storybook Intervention Reduce Teleological Misunderstandings? *Evolution: Education and Outreach*, *13*(1), 1–19. https://doi.org/10.1186/s12052-020-00127-7.

Bryant, D. P., Bryant, B. R., Dougherty, B., Roberts, G., Pfannenstiel, K. H., & Lee, J. (2020). Mathematics performance on integers of students with mathematics difficulties. *Journal of Mathematical Behavior*, *58*(June 2019), 100776.1-13. https://doi.org/10.1016/j.jmathb.2020.100776.

Castellani, G., & Schwartz, M. (2020). Immunological Features of Non-neuronal Brain Cells: Implications for Alzheimer's Disease Immunotherapy. *Trends in Immunology*, *41*(9), 794–804. https://doi.org/10.1016/j.it.2020.07.005.

Cazals, C., Lyser, S., & Kuentz-Simonet, V. (2023). How Sustainable are Daily Medicine Consumption Practices? The case of a fragile coastal area, Arcachon Bay (SW, France). *Journal of Cleaner Production*, *416*(June 2022), 137866.1-15. https://doi.org/10.1016/j.jclepro.2023.137866.

Conway, C. M. (2020). How does the brain learn environmental structure? Ten core principles for understanding the neurocognitive mechanisms of statistical learning. *Neuroscience and Biobehavioral Reviews*, *112*(February), 279–299. https://doi.org/10.1016/j.neubiorev.2020.01.032.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.

Dantas, L. A., & Cunha, A. (2020). An Integrative Debate on Learning Styles and The Learning Process. *Social Sciences and Humanities Open*, *2*(1), 100017.1-5. https://doi.org/10.1016/j.ssaho.2020.100017.

Fitriasari, P., Suhendra, Suryadi, D., & Nurlaelah, E. (2025). Textbook analysis of integers content using the praxeology framework. *Jurnal Elemen*, *11*(3), 577–596. https://doi.org/10.29408/jel.v11i3.29859.

Gennari, R., Matera, M., Morra, D., Melonio, A., & Rizvi, M. (2023). Design for Social Digital Well-Being With Young Generations: Engage Them and Make Them Reflect. *International Journal of Human Computer Studies*, *173*(January), 103006.1-21. https://doi.org/10.1016/j.ijhcs.2023.103006.

Gordon, R. A., Peng, F., Curby, T. W., & Zinsser, K. M. (2021). An Introduction to The Many-Facet Rasch Model as a Method to Improve Observational Quality Measures with an Application to Measuring The Teaching Of Emotion Skills. *Early Childhood Research Quarterly*, *55*(Quarter 2021), 149–164. https://doi.org/10.1016/j.ecresq.2020.11.005.

Guerra-Reyes, F., Guerra-Dávila, E., Naranjo-Toro, M., Basantes-Andrade, A., & Guevara-Betancourt, S. (2024). Misconceptions in the Learning of Natural Sciences: A Systematic Review. *Education Sciences*, *14*(5), 1–23. https://doi.org/10.3390/educsci14050497.

Guggemos, J. (2021). On the predictors of Computational Thinking and Its Growth at The High-School Level. *Computers and Education*, *161*(March 2020), 104060.1-15. https://doi.org/10.1016/j.compedu.2020.104060.

Hamzah, N., Maat, S. M., & Ikhsan, Z. (2021). A Systematic Review on Pupils' Misconceptions and Errors in Trigonometry. *Pegem Egitim ve Ogretim Dergisi*, *11*(4), 209–218. https://doi.org/10.47750/pegegog.11.04.20.

Harun, N. A., Cuevas, K. G., Asakil, O., Alviar, J., & Solon, L. J. (2023). Assessing Students' Mastery and Misconceptions in the Fundamental Operations on Integers. *International Journal of Science, Technology, Engineering and Mathematics*, *3*(3), 36–55. https://doi.org/10.53378/353000.

Huang, Y.-C. (2021). *Comparison and Contrast of Piaget and Vygotsky's Theories*. https://doi.org/10.2991/assehr.k.210519.007.

Hughes, E. M., Riccomini, P. J., & Lee, J. Y. (2020). Investigating written expressions of mathematical reasoning for students with learning disabilities. *Journal of Mathematical Behavior*, *58*(June 2020), 100775.1-14. https://doi.org/10.1016/j.jmathb.2020.100775.

Inayati, U. (2020). Strategi Guru Dalam Menerapkan Pembelajaran Hots Menggunakan Model Problem Based Learning. *Auladuna : Jurnal Prodi Pendidikan Guru Madrasah Ibtidaiyah*, *2*(2), 27–34. https://doi.org/10.36835/au.v2i2.410.

Kotronoulas, G., Miguel, S., Dowling, M., Fernández-Ortega, P., Colomer-Lahiguera, S., Bağçivan, G., Pape, E., Drury, A., Semple, C., Dieperink, K. B., & Papadopoulou, C. (2023). An Overview of the Fundamentals of Data Management, Analysis, and Interpretation in Quantitative Research. *Seminars in Oncology Nursing*, *39*(2), 1–9. https://doi.org/10.1016/j.soncn.2023.151398.

Kristoffersson, A., & Lindén, M. (2022). A Systematic Review of Wearable Sensors for Monitoring Physical

Activity. *Sensors*, *22*(2), 1–39. https://doi.org/10.3390/s22020573.

Linacre, N. A., Whiting, S. N., Baker, A. J. M., Angle, J. S., & Ades, P. K. (2003). Transgenics and phytoremediation: The Need for an Integrated Risk Assessment, Management, And Communication Strategy. *International Journal of Phytoremediation*, *5*(2), 181–185. https://doi.org/10.1080/713610179.

Mandinach, E. B., & Schildkamp, K. (2021). Misconceptions about data-based decision making in education: An exploration of the literature. *Studies in Educational Evaluation*, *69*(September 2019), 100842 1–10. https://doi.org/10.1016/j.stueduc.2020.100842.

Mejía-Rodríguez, A. M., Luyten, H., & Meelissen, M. R. M. (2021). Gender Differences in Mathematics Self-concept Across the World: an Exploration of Student and Parent Data of TIMSS 2015. *International Journal of Science and Mathematics Education*, *19*(6), 1229–1250. https://doi.org/10.1007/s10763-020-10100-x.

Menegol, N. A., Ribeiro, S. N. S., de Paula, A. C., Montemezzo, D., & Sanada, L. S. (2022). A Cross-Cultural Adaptation and Content Validity of COMFORTneo Scale into Brazilian Portuguese. *Journal of Pain and Symptom Management*, *64*(6), e323–e330. https://doi.org/10.1016/j.jpainsymman.2022.08.006.

Moons, F., Vandervieren, E., & Colpaert, J. (2022). Atomic, reusable feedback: a semi-automated solution for assessing handwritten tasks? A crossover experiment with mathematics teachers. *Computers and Education Open*, *3*(December 2022), 100086.1-17. https://doi.org/10.1016/j.caeo.2022.100086.

Mubarik, Budiarto, M. T., & Sulaiman, R. (2020). Cognitive adaptation of pre-service mathematics teachers in construction and reconstruction of quadrilateral relations. *Journal for the Education of Gifted Young Scientists*, *8*(3), 1125–1134. https://doi.org/10.17478/JEGYS.738626.

Muis, K. R., Etoubashi, N., & Denton, C. A. (2020). The catcher in the lie: The role of emotions and epistemic judgments in changing students' misconceptions and attitudes in a post-truth era. *Contemporary Educational Psychology*, *62*(July), 101898.1-13. https://doi.org/10.1016/j.cedpsych.2020.101898.

Nastiti, F. F., & Syaifudin, A. H. (2020). Hubungan Pemahaman Konsep Matematis Terhadap Hasil Belajar Siswa Kelas Viii Smp N 1 Plosoklaten Pada Materi Lingkaran. *PHI: Jurnal Pendidikan Matematika*, *4*(1), 8. https://doi.org/10.33087/phi.v4i1.80.

Pals, F. F. B., Tolboom, J. L. J., & Suhre, C. J. M. (2023). Development of a formative assessment instrument to determine students' need for corrective actions in physics: Identifying students' functional level of understanding. *Thinking Skills and Creativity*, *50*(October 2022), 101387.1-12. https://doi.org/10.1016/j.tsc.2023.101387.

Pattabiraman, K., Muchnik, S. K., & Sestan, N. (2020). The Evolution of The Human Brain and Disease Susceptibility. *Current Opinion in Genetics and Development*, *6*, 91–97. https://doi.org/10.1016/j.gde.2020.05.004.

Retnawati, H., Rafi, I., Mahmudi, A., & Arliani, E. (2023). A phenomenological study of challenges that prospective mathematics teachers face in developing mathematical problems that require higher-order thinking skills. E*urasia Journal of Mathematics, Science and Technology Education, 19*(10), 1–21. https://doi.org/https://doi.org/10.29333/ejmste/13631.

Sebsibe, A. S., Argaw, A. S., Bedada, T. B., & Mohammed, A. A. (2023). Swaying pedagogy: A new paradigm for mathematics teachers education in Ethiopia. *Social Sciences and Humanities Open*, *8*(1), 100630.1-10. https://doi.org/10.1016/j.ssaho.2023.100630.

Shahparvari, S., Fadaki, M., & Chhetri, P. (2020). Spatial accessibility of fire stations for enhancing operational response in Melbourne. *Fire Safety Journal*, *117*, 103149.1-36. https://doi.org/10.1016/j.firesaf.2020.103149.

Suwarto, S., Hidayah, I., Rochmad, R., & Masrukan, M. (2023). Intuitive thinking: Perspectives on Intuitive Thinking Processes in Mathematical Problem Solving Through a Literature Review. *Cogent Education*, *10*(2), 1-15. https://doi.org/10.1080/2331186X.2023.2243119.

U. Hasanah, N. Fajrie, & D. Kurniati. (2023). Peningkatan Pemahaman Konsep Matematika Siswa Sd Melalui Pendidikan Matematika Realistik Berbantuan Ular Tangga. *PENDASI Jurnal Pendidikan Dasar Indonesia*, *7*(2), 321–330. https://doi.org/10.23887/jurnal_pendas.v7i2.2441.

Vrotsou, K., Subiza-p, M., Ochoa, L., Retana, D., Duo, I., & Ibarluzea, J. (2023). Environmental health knowledge of healthcare professionals : Instrument development and validation using the Rasch model. *Environmental Research*, *235*(July 2023), 1–7. https://doi.org/10.1016/j.envres.2023.116582.

Wen, R., & Dubé, A. K. (2022). A Systematic Review of Secondary Students' Attitudes Towards Mathematics and its Relations With Mathematics Achievement. *Journal of Numerical Cognition*, *8*(2), 295–325. https://doi.org/10.5964/jnc.7937.